

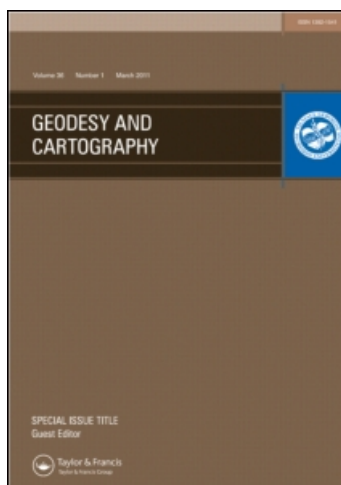
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### Program extension for diagram maps

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## PROGRAM EXTENSION FOR DIAGRAM MAPS

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**Abstract.** Absolute statistical data are very often expressed by a diagram in thematic maps. The ArcGIS 9 software from ESRI is commonly used for the production of cartographic output, but there are only a few possibilities for how to express data by diagram maps. A program extension called “Diagram map creator” was developed at the Department of Geoinformatics, Palacký University in 2010. This extension serves as a supplement for the automatic generation of various diagram maps. The program code, user interface and the possibilities of and the use of the “Diagram map creator” extension are presented in this article. Some examples of thematic maps are also shown.

**Keywords:** ArcGIS, thematic cartography, program, point diagram, line diagram, area diagram.

### 1. Introduction

The main division of maps is between topographic and thematic maps. Thematic maps represent the distribution of one particular phenomenon (Kraak, Ormeling 2003). Statistical data are very often expressed in thematic maps and are divided into qualitative or quantitative data. Quantitative data are absolute or relative data. Absolute and relative data are expressed by different cartographic methods in maps. Absolute data, which have a non-area related ratio, are expressed by diagrams in maps.

Software for geographic information systems (GIS) supports the production of cartographic output. The benefit of thematic map creation is the automatic map element construction in GIS. Automatic creation is based on the values of attribute data. Cartographic functionalities are on different levels in various GIS software. Some cartographic methods are satisfactorily supported, and some methods are not supported at all. The best cartographic functionality is found in the software ArcGIS from ESRI according to the research project conducted by this author (Dobesova 2009). That prior project compared more than 13 commercial software and open source GIS software by the specific method called Car-toEvaluation.

### 2. Diagram maps

One cartographic method is a diagram map. This method is also called cartodiagram in Central European literature (Kanok1992, 1999; Pravda 2006). Values of absolute data

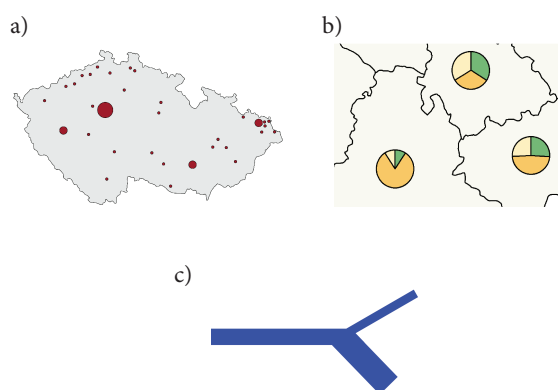
are mainly expressed by graphic variable of the symbols – size. The size of the symbol increases with an increasing quantitative value of the object which the symbol represents. Different symbols serve as diagram symbols that are widely used in maps. Pie charts or stacked bar charts are often used for cumulative diagrams.

Kraak and Ormeling (2003) called this method the “absolute proportional method” and considered more than simple geometric symbols. Both simple symbols and compound symbols, such as two semicircles for comparison of two values, belong to the absolute proportional method. The principle of visualization is the same – size expresses quantity. Slocum *et al.* (2004) used the term “proportional symbol maps” and “multivariate maps” for maps with compound symbols. The terminology is different in various cartographic literature and also in GIS software.

Emphasis is laid upon the differentiation of diagram symbols by location – into points, lines or areas. Examples of diagram symbols according to location are in Fig. 1. Three types of cartographic diagram methods are named according to location:

- point diagram,
- area diagram,
- line diagram.

Kanok (1992) divided all diagram symbols according to the method of construction and according to the number of phenomena. The division is the same for point and area locations.



**Fig. 1.** Diagram symbols according to location:  
a – located by points, b – located by areas, c – located by lines

Point and area diagram symbols are:

- simple,
- composite,
- cumulative,
- structural,
- comparative,
- dynamic.

Anamorphous diagram is a exceptional area diagram.

Line diagram symbols are:

- vectorial
  - accessible,
  - flow directional,
- ribbony
  - simple,
  - composite,
  - cumulative,
  - structural,
  - comparative,
  - dynamic,
  - isochronic.

Software ArcGIS automatically creates a simple point, line or area diagram. Some types of composite and comparative diagrams can not be created automatically. The lack of some cartographic diagram map methods was the reason for the creation of a new program extension (Valent 2010). The extension called “Diagram map creator” for automated production of selected diagram map types was created in our research. This extension was created to generate the types of diagram maps that the ArcGIS software could not automatically create.

### 3. Program extension

The first step was an exploration of all available types and distributions of diagram maps in ArcGIS. The list of diagram maps was based on Kanok’s division (1992). Table 1 is an overview of the present or missing diagram map methods located by point, line or area. The most serious need was in the area of line diagram maps. Only simple line diagrams could be created automatically.

**Table 1.** List of possible diagram maps in ArcGIS

Point and area diagram maps in ArcGIS		
Types of diagram map	ArcGIS	Notes
Simple	YES	many types of diagrams
Composite	NO	
Cumulative	YES	“Pie charts” and “Stacked charts” 2D and 3D forms
Structural	YES	“Pie charts”
Comparative	NO	
Dynamic	YES/ NO	only bar charts
Anamorphous	NO	
Line diagrams in ArcGIS		
Vector accessible	NO	
Vector flow directional	NO	
Ribbony simple	YES	only one direction
Ribbony composite	NO	
Ribbony cumulative	NO	
Ribbony structural	NO	
Ribbony comparative	NO	
Ribbony dynamic	NO	
Ribbony isochronic	NO	

#### 3.1. Interface of extension

The second step was programming the missing diagram methods in ArcGIS 9. The programming language Microsoft Visual Basic for Application (VBA) was chosen. VBA is supported and well documented by ESRI. One program extension was designed. It is possible to put this extension onto the optional tool bar in ArcGIS.

The interface extension consists of the main dialog window and several other windows for each type of diagram. The main dialog window serves to choose the type of diagram map (Fig. 2). There are two sections on the left side of window: “Point and area based diagrams” and “Line based diagrams”. An explanation picture for each diagram type is on the right side. The command button, “Run”, opens a new dialog window for the selected diagram type. The arrangement of the second window depends on the diagram type. Generally there are sections for choosing the name of the layer, the name of the field, the classification method, the colours and the working directory settings. An example map is also on the right side (Fig. 3). The button, “Create diagram”, starts the construction of the diagram. All extension interfaces are intuitive for users.

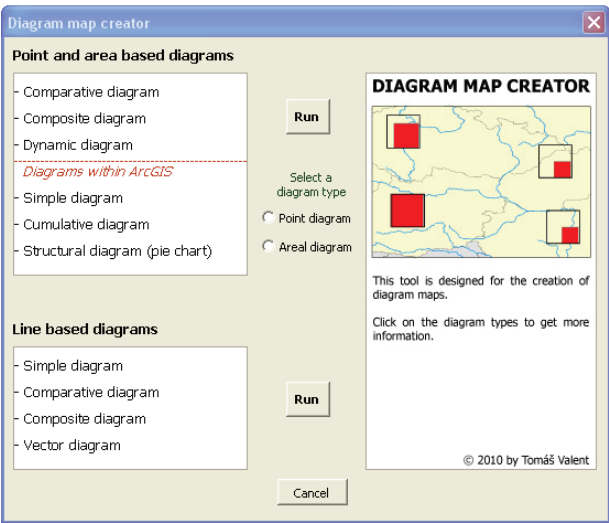


Fig. 2. Interface of program Diagram map creator

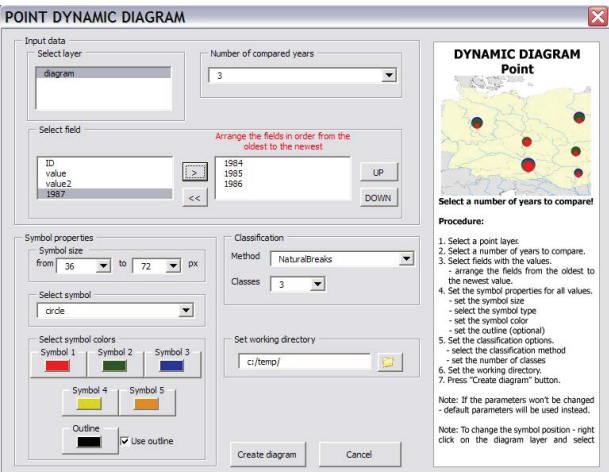


Fig. 3. Dialog window for Point dynamic diagram map

3.2. Program code

There are several ways to extend the functionality in ArcGIS software. The first possibility is scripting in the Python language. The Python script method is the best for batch processing. Scripting in Python is suitable for processing large amounts of data. The disadvantage is that there is no definition of the special window interface for setting option parameters except for the name of the layers and directories. The second way to extend the functionality is the creation of an application interface (API) based on ArcObjects. The functionality of ArcObjects can be accessed using four APIs: COM, .NET, Java, and C++. An API advantage is that there is a dialog window definition for setting options in these scripting languages. Therefore, Microsoft Visual Basic for Application (VBA) was chosen for purposes of this research.

All functions in ArcGIS software are based on special objects – ArcObjects components. The APIs support the use of the ArcObject components. Several ArcObject components were called in program code, such as the method for a new group layer creation, the method to attribute data classification, the class rendering and the color browser. The program extension consists of eleven

Visual Basic Forms with program codes. The program codes prevent errors. Wrong user settings are handled by “If Then Else” programming construct in VBA. Expected errors included the wrong input layer name, a few or too many attribute values, the wrong name of the working directory, too small or too big symbol size, and overwriting layers.

The resulting diagrams are stored as a new group layer in the ArcGIS project. Diagrams are not stored like graphic objects. This solution has several advantages. It is possible to switch on or off group layer with the display of diagram symbols. It is possible to change the fill color and the outline color of the diagram symbols (Fig. 4). It is possible to change the symbols and the size of the symbols. The last advantage is the ability to modify the statistical value separation on the interval scale. Finally, it is possible to convert group layer to graphic objects at the end of the map creation. Before printing the map, it is recommended that the final placement of the diagram symbols be made.

Specifically designed True Type Font (TTF) named „ESRI\_carto“ is the necessary supplement of the extension (Fig. 5). The TTF file is simply added to Windows operating system fonts.

The defined font contains new geometric symbols for diagram creation including semicircles, rectangles, triangles, pentagons, and rhombuses. All the symbols are in both the transparent form and the fill form. The transparent form is for comparative diagram symbols.

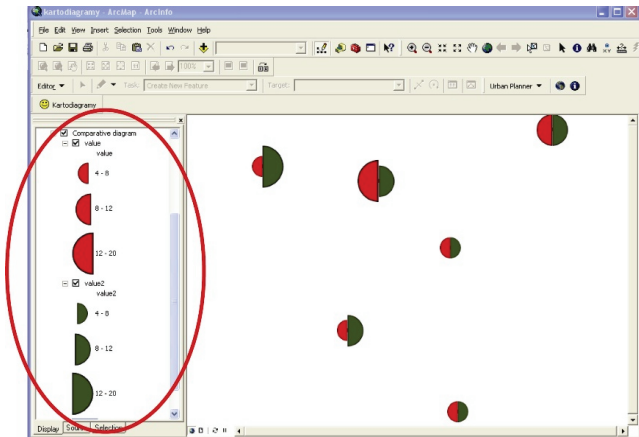


Fig. 4. Group layer in the table of content, point comparative diagram symbols for two phenomena

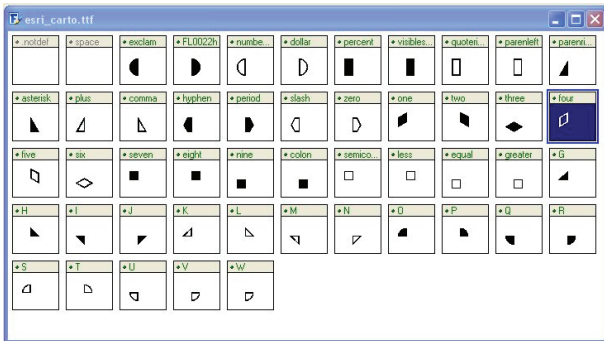


Fig. 5. True type font “ESRI\_carto“

Fig. 6 shows examples of symbols for point and area comparative diagram maps. The first symbol is a square symbol for one phenomenon (compare with average or supposed value). The second symbol is a pentagon diagram for a two phenomena comparison. The third symbol is a diagram for a three phenomena comparison and the fourth diagram is for a four phenomena comparison.



Fig. 6. Symbols for comparative diagram maps

### 3.3. Download and utilization

The “Diagram map creator” extension for ArcGIS 9.3 is downloadable for free from the web page <<http://www.geoinformatics.upol.cz/dprace/magisterske/valent10/>>. All dialog windows, program user messages, program comments and instructions for installation are in the English language. Furthermore, a video tutorial was created for the quick practice and use of this extension. This video is on the above mentioned web page and on YouTube.

### 3.4. Example maps

The functionality of the program extension was tested by the creation of sample maps. The program extension automatically creates three new types of diagram maps for

point and area features: composite, comparative and dynamic diagram maps. The next figure shows an example of the comparative area diagram map (Fig. 7). The comparative value is an average number of inhabitants in districts of the Czech Republic. This average value is visualized by the black transparent triangles in every district. The average is automatically counted by the program. The absolute value in every district is expressed by the yellow triangles. The program automatically places triangle symbols to match the lower-left corner of those triangles.

Fig. 8 shows an area dynamic diagram map of the cereal harvest development in the Czech and Slovak Republics in the years 1960, 1970 and 1980. The three circles are automatically placed to match the bottoms of the circles. The difficulty is to set the correct classification in this type of diagram. The limits of the value scale are based originally on one attribute value in ArcGIS. The extension puts all attribute values (three years in this case) in one supplemental attribute table. Classification is automatically constructed on this supplemental table. The program extension also serves to creation line diagram maps. It is possible to create three line diagrams automatically: vector accessible, ribbonary comparative and composite diagram maps. Fig. 9 shows a line ribbonary comparative diagram map of truck and automobile traffic on the roads in the Olomouc district. The thickness of the line expresses the number of automobiles and trucks in a 24 hours period. The program extension automatically adjusts the thickness of line and the line offset according to the count.

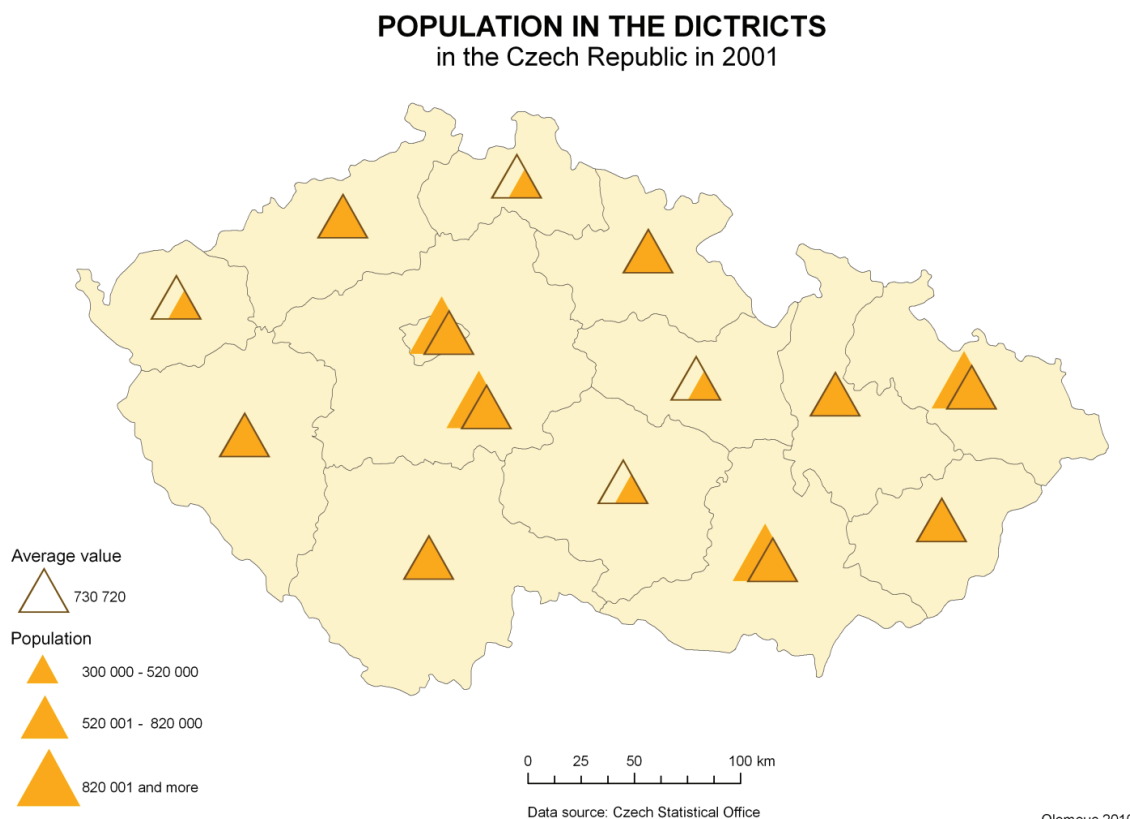


Fig. 7. Comparative area diagram map of the number of inhabitants



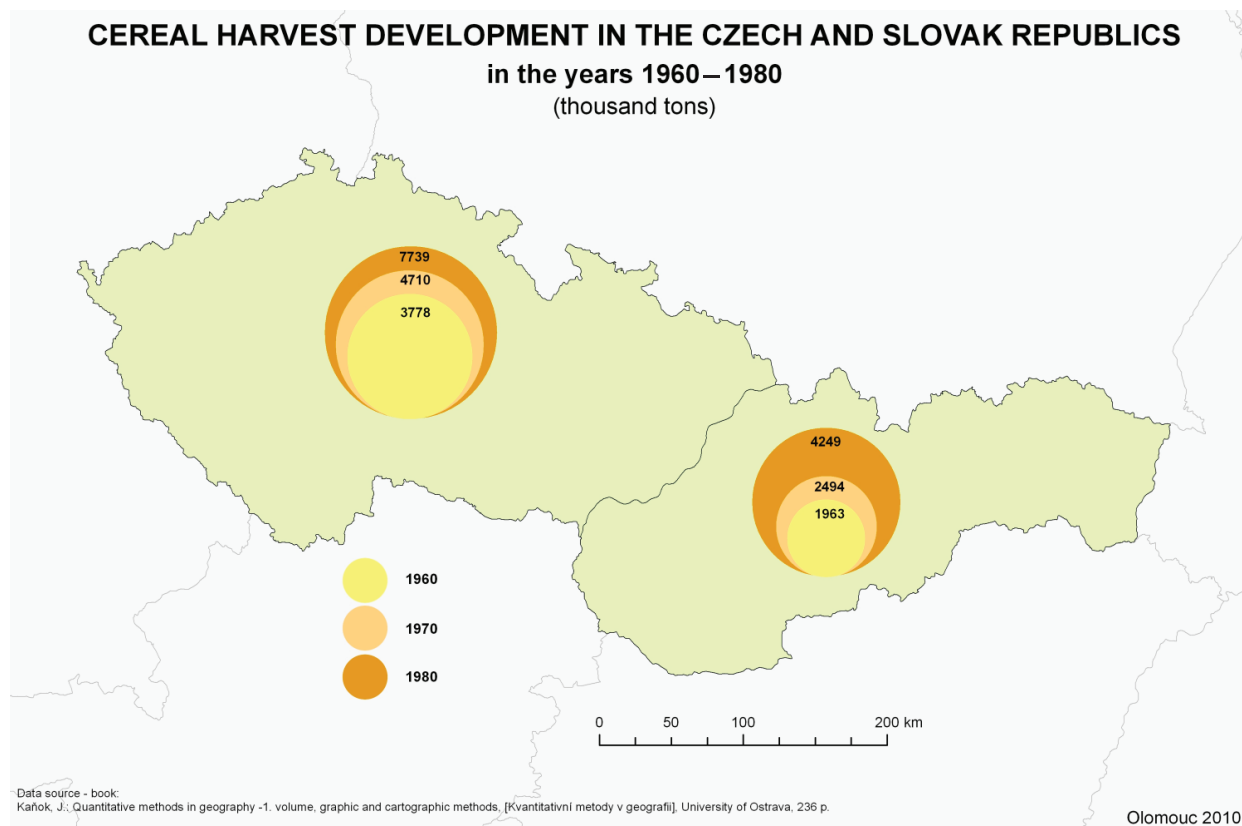


Fig. 8. Area dynamic diagram map of crop production

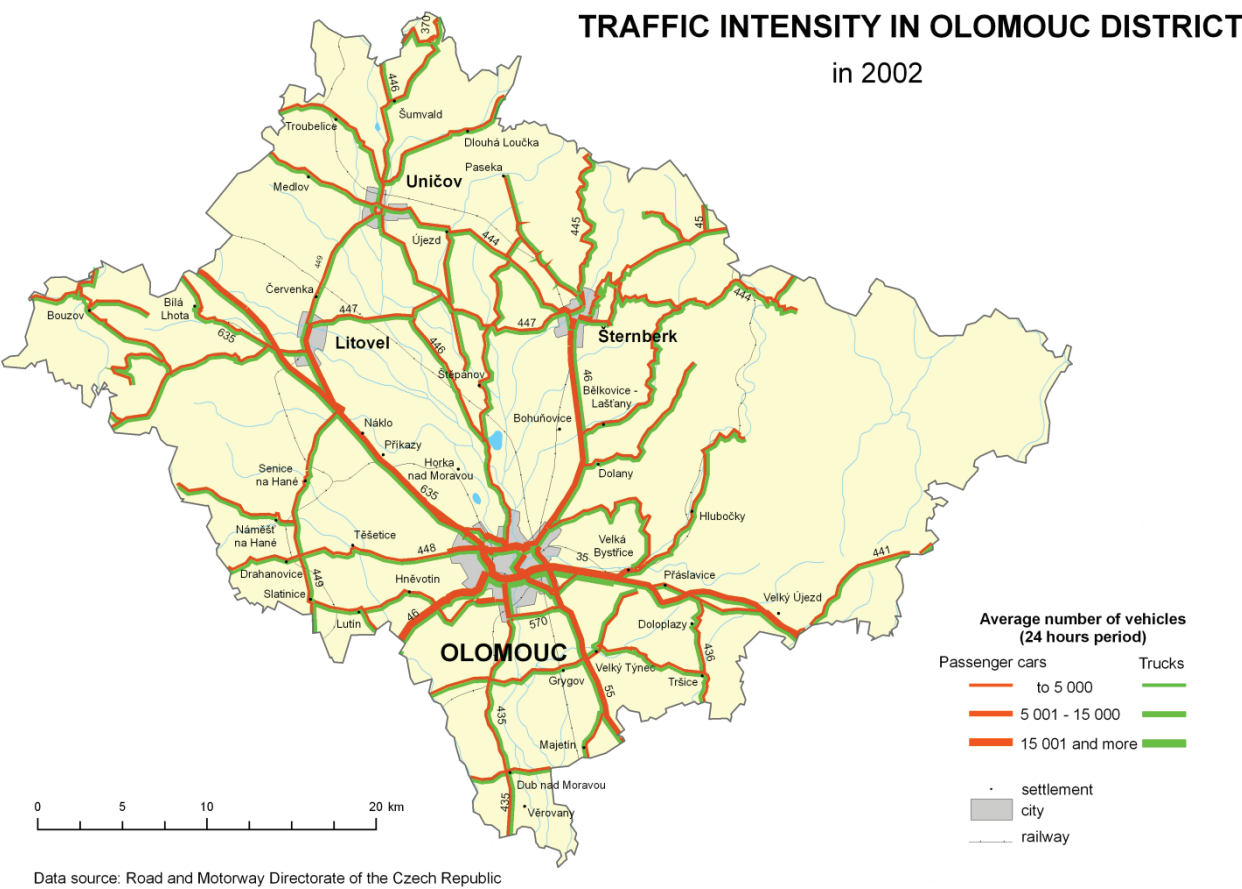


Fig. 9. Line ribbon comparative diagram map of traffic

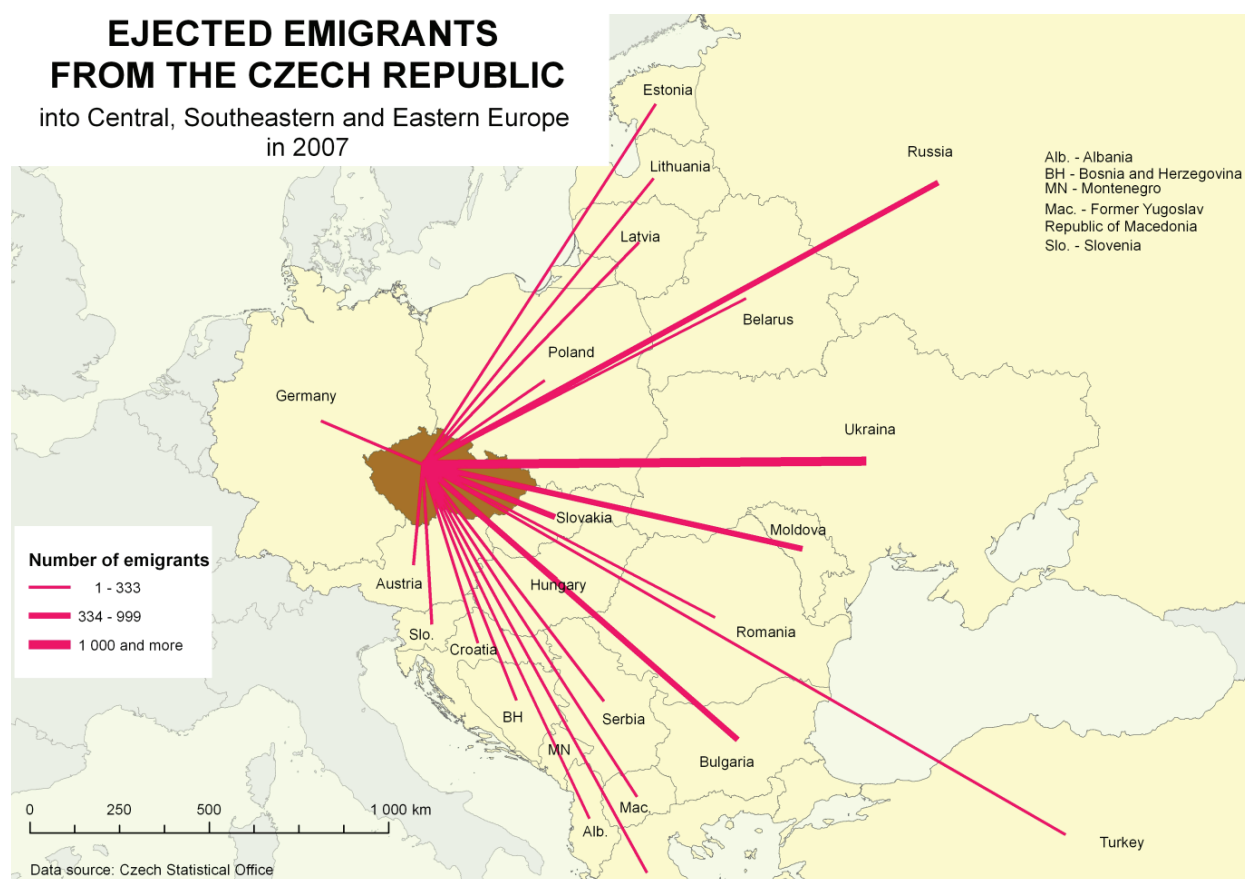


Fig. 10. Line vector accessible diagram map of emigrants

The final example map, Fig. 10, is a vector accessible diagram map of ejected emigrants in the Czech Republic in 2007 and to their country of origin. The extension automatically creates vector lines as connections of the points. The thickness of the lines expresses the number of emigrants. The creation of other types of line diagram maps is more difficult than the creation of point and area diagram maps. The automatic creation of cumulative, structural and dynamic line diagram maps is not solved by this extension program.

The extension does not prevent some cartographic mistakes in the placement of the diagrams. The intelligent system in cartography, described in Brus *et al.* (2009), should be used for the complex storing of cartographic knowledge.

#### 4. Conclusions

Utilization of the program extension “Diagram map creator” reduces manual work during map creation. Three new types of point or area diagram maps and three new types of line diagram maps are possible. The number of diagram maps is multiplied by the use of the new TTF symbols. The “Diagram map creator” program extension, file with TTF and installation instruction are downloadable, for free, from the web. Several testing maps demonstrate the application of the extension.

Manual diagram creation and manual classification are very time consuming. The “Diagram map creator” program extension promises to be extremely helpful for future cartographers. The ability to automatically diagram large amounts of data into point, line and area features on a map is a valuable asset to field of cartography.

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